K.S. SCHOOL OF ENGINEERING AND MANAGEMENT, BANGALORE - 560109
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING
SESSION: 2021 – 2022 (ODD SEMESTER)
CO-PO Mapping

Course: Power System Analysis – 2			
Type: Core		**Course Code: 18EE71**	
No of Hours			
Theory (Lecture Class)	Practical/Field Work/Allied Activities	Total hours/Week	Total teaching hours
3	-	3	40
Marks			
Internal Assessment	Examination	Total	Credits
40	60	100	3

Aim/Objectives of the Course

1. To explain formulation of network models and bus admittance matrix for solving load flow problems.
2. To discuss optimal operation of generators on a bus bar and optimum generation scheduling.
3. To explain symmetrical fault analysis and algorithm for short circuit studies.
4. To explain formulation of bus impedance matrix for the use in short circuit studies on power systems.
5. To explain numerical solution of swing equation for multi-machine stability

Course Learning Outcomes

After completing the course, the students will be able to

CO1	**Build** network matrices and bus admittance matrices with basics of elementary graph theory.	**Applying (K3)**
CO2	**Determine** the parameters of power systems by steady state power flow analysis using numerical iterative techniques.	**Applying (K3)**
CO3	**Solve** load flow problems by Newton Raphson and Fast Decoupled methods.	**Applying (K3)**
CO4	**Find** solution for economic load dispatch issues and unit commitment problems.	**Applying (K3)**
CO5	**Calculate** short circuit faults in power system networks using bus impedance matrix and **apply** Point by Point method and Runge Kutta method to solve Swing Equation.	**Applying (K3)**

Syllabus Content

Module 1: Network Topology: Introduction and basic definitions of Elementary graph theory Tree, cut-set, loop analysis. Formation of Incidence Matrices. Primitive network-Impedance form and admittance form, Formation of Y Bus by Singular Transformation. Y bus by Inspection Method. Illustrative examples. **LO:** At the end of this session the student will be able to 1. Define terms related to Elementary graph theory. 2. Find Incidence Matrices for the given Network. 3. Build tree, cotree, cut-set and tie-set matrix 4. Define primitive network and give the representation of a typical component and arrive at their performance equations in impedance and admittance forms. 5. Find the Y_{Bus} by direct inspection method for a given system.	**CO1** 8 hrs PO1-3 PO2-2 PO6-1 PO12 -1 PSO1-2 PSO2-1

Module-2: Load Flow Studies: Introduction, Classification of buses. Power flow equation, Operating Constraints, Data for Load flow, Gauss Seidal iterative method. Illustrative examples. **LO:** At the end of this session the student will be able to 1. Explain the different types of buses considered during power system load flow. 2. Discuss the significance of slack bus in load flow studies. 3. Discuss power flow equation and operating constraints in power system. 4. Write the algorithm of Gauss – Seidel load flow solution for a power system with a slack bus and number of PQ buses. 5. Determine the complex voltage, Power and current for the given network using Gauss – Seidel load flow.	**CO2** 8 hrs. PO1-3 PO2-2 PO6-2 PO12-1 PSO1-2 PSO2-1
Module-3: Load Flow Studies(continued): Newton-Raphson method derivation in Polar form, Fast decoupled load flow method, Flow charts of LFS methods. Comparison of Load Flow Methods. Illustrative examples. **LO:** At the end of this session the student will be able to 1. Derive Newton-Raphson method in Polar form. 2. Determine the complex voltage, Power and current for the given network using Newton-Raphson method. 3. Solve load flow problems by Newton Raphson and Fast Decoupled methods 4. Draw Flow charts of LFS methods 5. Compare different Load Flow Methods.	**CO3** 8 hrs PO1-3 PO2-2 PO6-2 PO12-1 PSO1-2 PSO2-1
Module–4: Economic Operation of Power System: Introduction and Performance curves Economic generation scheduling neglecting losses and generator limits Economic generation scheduling including generator limits and neglecting losses Economic dispatch including transmission losses Derivation of transmission loss formula. Illustrative examples. **Unit Commitment**: Introduction, Constraints and unit commitment solution by prior list method and dynamic forward DP approach (Flow chart and Algorithm only). **LO:** At the end of this session the student will be able to 1. Explain the Performance curves. 2. Calculate the Incremental fuel cost for a plant and derive transmission loss formula. 3. Find solution for economic load dispatch issues. 4. Discuss the constraints in unit commitment. 5. Explain the unit commitment solution by prior list method and dynamic forward DP approach.	**CO4** 8hrs PO1-3 PO2-2 PO6-2 PO12-1 PSO1-2 PSO2-1
Module–5: Symmetrical Fault Analysis: Z Bus Formulation by Step-by-step building algorithm without mutual coupling between the elements by addition of link and addition of branch, Illustrative examples. Z bus Algorithm for Short Circuit Studies excluding numerical. **Power System Stability**: Numerical Solution of Swing Equation by Point-by-Point method and Runge Kutta Method. Illustrative examples. **LO:** At the end of this session the student will be able to 1. Explain the algorithm for short circuit studies. 2. Derive an expression for transmission loss as a function of plant generation for two plant system. 3. Derive the generalised algorithm for finding the elements of bus impedance matrix when a link is added to the partial network. 4. Explain with relevant diagrams the point-by-point method of solving swing equation.	**CO5** 8hrs PO1-3 PO2-2 PO6-2 PO12-1 PSO1-2 PSO2-1

5. Explain the steps involved in solving power system stability solutions of swing equation using Runge Kutta Method.

Text Books

1. D P Kothari, I J Nagrath, "**Modern Power System Analysis**", 4th Edition, McGraw Hill, 2011.
2. Glenn W. Stagg Ahmed H Ei – Abiad, "**Computer Methods in Power Systems Analysis**", 1 st Edition, Scientific International Pvt. Ltd, 2019.
3. Allen J Wood et al, "**Power Generation Operation and Control**", 2nd Edition, Wiley, 2016.

Reference Books

1. M.A. Pai, "**Computer Techniques in Power System Analysis**", 2nd Edition, McGraw Hill, 2012.
2. Hadi Saadat, "**Power System Analysis**", 2nd Edition, McGraw Hill, 2002.

Useful Websites

1. **http://elearning.vtu.ac.in/econtent/courses/video/EEE/EE72.html**
2. **https://nptel.ac.in/courses/108/102/108102047/**
3. **https://www.youtube.com/watch?v=MYGT1_9mwpg**

Useful Journals

1. Energies: https://www.mdpi.com/1996-1073/13/12/3173
2. International Journal of Industrial Electronics, Control and Optimization (IECO): https://ieco.usb.ac.ir/article_4169_8580da73db42e84571c744aa72ce26e4.pdf

Teaching and Learning Methods:
Lecture class: 40 hours

Assessment
Type of test/examination: Written examination
Continuous Internal Evaluation (CIE): 40 marks (30 marks -Average of three tests + 10 marks Assignments)
Semester End Exam (SEE): 100 marks (students have to answer all main questions) which will be reduced to 60 Marks.
Test duration: 1:30 hours
Examination duration: 3 hours

CO to PO Mapping

PO1: Science and engineering Knowledge	**PO7:** Environment and Society
PO2: Problem Analysis	**PO8:** Ethics
PO3: Design & Development	**PO9:** Individual & Team Work
PO4: Investigations of Complex Problems	**PO10:** Communication
PO5: Modern Tool Usage	**PO11:** Project Management & Finance
PO6: Engineer & Society	**PO12:** Life long Learning

PSO1: Graduates should be able to develop an inclination towards acquiring analytical, technical, managerial and communicative skills by gaining knowledge in fundamental concepts in the field of Electrical sciences and allied subjects.
PSO2: Graduates should be able to Contribute for the development of society by providing technical solutions to complex electrical engineering problems through life-long learning.

CO	PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
18EE71	K-level														
CO1	K3	3	2	-	-	-	1	-	-	-	-	-	1	2	1
CO2	K3	3	2	-	-	-	2	-	-	-	-	-	1	2	1
CO3	K3	3	2	-	-	-	2	-	-	-	-	-	1	2	1
CO4	K3	3	2	-	-	-	2	-	-	-	-	-	1	2	1
CO5	K3	3	2	-	-	-	2		-	-	-	-	1	2	1

Course in charge

Head of the Department

Principal